

ST012 Remedial Action

Field Variance Memorandum 7 – Pilot Study

Implementation – Injection-Extraction Modifications

Date: 9 November 2018 From: Amec Foster Wheeler Environment & Infrastructure, Inc.
To: Catherine Jerrard (AFCEC)

Subject: **Injection-Extraction Modifications**
Pilot Study Implementation Work Plan
Former Liquid Fuels Storage Area (ST012)
Former Williams Air Force Base – Mesa, Arizona

1.0 INTRODUCTION

This Field Variance Memorandum (Memo), prepared as a variance to the Final Pilot Study Implementation Work Plan (Amec Foster Wheeler, 2018) to address modifications to the planned injection and extraction locations and injection quantities for the Pilot Study at the Former Liquid Fuels Storage Area (ST012) at the former Williams Air Force Base (ADEQ, 2018).

2.0 SUMMARY OF MODIFICATIONS

The injection and extraction locations were reviewed against the current understanding of benzene concentration distributions in the cobble zone (CZ), upper water-bearing zone (UWBZ), and lower saturated zone (LSZ). The injection quantities from Table 3-1 of the Workplan and injection and extraction pairings from Table 4-1 of the Workplan were reviewed and updated as described in Attachment 1. Figures 3-2 through 3-4 from the Workplan were also updated to include the current benzene distribution, and the modified injection-extraction locations. These figures are included in Attachment 2 and also show revisions to monitoring locations based on the modified injection-extraction plan. Injection sequencing is intended as a guide but may be modified in the field based on logistics (e.g., if maintenance on an extraction pump is ongoing the sequencing for injections in that area will be modified).

3.0 REFERENCES

Amec Foster Wheeler Environment & Infrastructure Inc., 2018. *Pilot Study Implementation Work Plan for Operable Unit 2 Revised Groundwater Remedy, Site ST012, Former Williams Air Force Base, Mesa, Arizona*. Prepared for the Air Force Civil Engineer Center. Final Report dated 5 April 2018. Contract No. FA8903-09-D-8572-0002

**ATTACHMENT 1 SUMMARY OF INJECTION-EXTRACTION
MODIFICATIONS BASED ON MOST RECENT BENZENE IN
GROUNDWATER DISTRIBUTION**

Summary of Injection-Extraction Modifications for Pilot Study Implementation Based on Most Recent Benzene in Groundwater Distribution

Original Pilot Study WP				Proposed Modification						
Injection Well	Associated Extraction Well(s)	Mass of TEA (tons) ¹	Subphase Mass of TEA (tons) ¹	Modification	Revised Mass of TEA (tons) ¹	Revised Subphase Mass of TEA ² (tons) ¹	Subphase 1 Sequence	Subphase 2 Sequence	Subphase 3 Sequence	Subphase 4 Sequence
CZ										
ST012-CZ10	ST012-CZ07	12	3	Eliminate injection at ST012-CZ10 due to low dissolved phase concentration. Continue extraction at ST012-CZ07 to promote some secondary distribution of sulfate from upgradient injections at ST012-SVE04D	0	0,0,0,0	N/A	N/A	N/A	N/A
ST012-CZ11	ST012-CZ07 ST012-CZ21	12	3	Eliminate injection at ST012-CZ11 due to low dissolved phase concentration. Continue extraction at ST012-CZ07 to promote some secondary distribution of sulfate from upgradient injections at ST012-SVE04D	0	0,0,0,0	N/A	N/A	N/A	N/A
ST012-CZ12	ST012-CZ07 ST012-CZ21	12	3	Eliminate injection at ST012-CZ12 due to low dissolved phase concentration. Continue extraction at ST012-CZ21 to promote some secondary distribution of sulfate from upgradient injections at ST012-CZ22	0	0,0,0,0	N/A	N/A	N/A	N/A
ST012-CZ16	ST012-CZ21	12	3	Eliminate injection at ST012-CZ16 due to low dissolved phase concentration. Continue extraction at ST012-CZ21 to promote some secondary distribution of sulfate from upgradient injections at ST012-CZ22	0	0,0,0,0	N/A	N/A	N/A	N/A
ST012-CZ22	ST012-CZ18 ST012-CZ19	12	3	Eliminate extraction at ST012-CZ19 due to low dissolved phase concentration	12	3,3,3,3	3	3	4	4
ST012-SVE04D	ST012-CZ18 ST012-CZ19	12	3	Eliminate extraction at ST012-CZ19 due to low dissolved phase concentration	12	3,3,3,3	4	4	4	3
UWBZ										
ST012-UWBZ10	ST012-UWBZ28	93	23	Change extraction from ST012-UWBZ28 to ST012-UWBZ25. Move 1/2 of planned injection quantity to ST012-UWBZ28. Inject over subphases 2-4 so that extraction can remain on in ST012-UWBZ28/LSZ51 during subphase 1	46	15,15,15,15	N/A	1	1	1
ST012-UWBZ12	ST012-UWBZ21	18	5	Eliminate injection at ST012-UWBZ12 due to low dissolved phase concentration.	0	0,0,0,0	N/A	N/A	N/A	N/A
ST012-UWBZ16	ST012-UWBZ22 ST012-UWBZ30	16	4	Eliminate injection at ST012-UWBZ16 due to low dissolved phase concentration.	0	0,0,0,0	N/A	N/A	N/A	N/A
ST012-UWBZ23	ST012-UWBZ30	46	11	Start with smaller injections and ramp up.	46	6,12,12,16	3	3	3	3
ST012-UWBZ28	Injection not originally planned in ST012-UWBZ28			Not originally planned as an injection well. Move 1/2 of planned injection quantity at ST012-UWBZ10 to ST012-UWBZ28. Inject in subphases 2-4 so that extraction can remain on in ST012-UWBZ28/LSZ51 during subphase 1	46	15,15,15,15	N/A	1	1	1
ST012-UWBZ29	ST012-UWBZ30	67	17	Delay injections to subphase 3 to 4. Turn off extraction at ST012-UWBZ21 until injections start. Reduce TEA injection mass to 1/3 original planned. Mass injection reduced based on site data and regulator concern with downgradient injections.	22	0,0,11,11	N/A	N/A	3	3
ST012-UWBZ32	ST012-UWBZ22	16	4	Eliminate injection at ST012-UWBZ32 due to low dissolved phase benzene concentration	0	0,0,0,0	N/A	N/A	N/A	N/A
ST012-UWBZ33	ST012-UWBZ22	118	29	No changes proposed	118	29,29,29,29	1	1	1	1
ST012-UWBZ34	ST012-UWBZ27	51	13	No changes proposed	51	13,13,13,13	1	1	1	1
ST012-UWBZ35	ST012-UWBZ26	60	15	No changes proposed	60	15,15,15,15	1	2	2	2
ST012-UWBZ36	ST012-UWBZ26	24	6	No changes proposed	24	6,6,6,6	1	1	1	1
LSZ										
ST012-W11	ST012-LSZ39	40	10	No changes proposed	40	10,10,10,10	2	3	3	2
ST012-W30	ST012-LSZ37	12	3	No changes proposed	12	3,3,3,3	3	3	3	3
ST012-W34	ST012-LSZ29	12	3	Eliminate injections at ST012-W34 and extraction at ST012-LSZ29 due to low dissolved-phase benzene concentrations	0	0,0,0,0	N/A	N/A	N/A	N/A
ST012-W36	ST012-LSZ29	12	3	Inject minimum dose (3 tons) at ST012-W36 during subphase 1 and evaluate migration/capture at ST012-LSZ43 and ST012-LSZ44. If good control by pumping at LSZ43, inject additional TEA at ST012-W36 (to total 1/2 of planned quantity for ST012-LSZ43 injection) and extract at ST012-LSZ43 during subphase 4. If poor capture of tracer at ST012-LSZ43, see injection at ST012-LSZ43. Eliminate extraction at ST012-LSZ29. Mass injection reduced based on site data and regulator concern with downgradient injections.	8	3,0,0,5?	3	N/A	N/A	3
ST012-W37	ST012-LSZ12	12	3	Inject minimum TEA dose (3 tons) at ST012-W37 during first subphase. Monitor for migration during subphases 2&3. Consider additional injection during subphase 4 depending on analysis of capture.	6	3,0,0,3?	3	N/A	N/A	3
ST012-LSZ08	ST012-LSZ09 ST012-LSZ37 ST012-LSZ51	16	4	Inject entire TEA quantity in subphase 1. This will free up extraction pump in ST012-LSZ51 and allow for injections in ST012-LSZ51 in subphases 2&3.	16	16,0,0,0	1	N/A	N/A	N/A
ST012-LSZ11	Injection not originally planned in ST012-LSZ11			Move TEA injection mass originally planned for ST012-LSZ47 and ST012-LSZ48 for subphase 4 to be injected in ST012-LSZ11 for subphase 4.	14	0,0,0,14	N/A	N/A	N/A	2
ST012-LSZ17	ST012-LSZ51	15	4	Move TEA injection from ST012-LSZ17 to ST012-LSZ51 and inject entire TEA quantity in subphases 2&3 after extraction in ST012-LSZ51 is terminated	0	0,0,0,0	N/A	N/A	N/A	N/A

Summary of Injection-Extraction Modifications for Pilot Study Implementation Based on Most Recent Benzene in Groundwater Distribution

Original Pilot Study WP				Proposed Modification						
Injection Well	Associated Extraction Well(s)	Mass of TEA (tons) ¹	Subphase Mass of TEA (tons) ¹	Modification	Revised Mass of TEA (tons) ¹	Revised Subphase Mass of TEA ² (tons) ¹	Subphase 1 Sequence	Subphase 2 Sequence	Subphase 3 Sequence	Subphase 4 Sequence
ST012-LSZ43	ST012-LSZ28 ST012-LSZ29	16	4	Eliminate extraction at ST012-LSZ28 and ST012-LSZ29. Extract at ST012-LSZ43. Delay injections at ST012-LSZ43 to subphase 4 and implement these injections only if subphase 1 injection at ST012-W36 shows poor connection to ST012-LSZ43. If injecting at ST012-LSZ43, inject 1/2 of original planned TEA and extract at ST012-W36. Allow sulfate to migrate toward ST012-LSZ44 with groundwater. Supplement with sulfate injections in future phases if necessary. Mass injection reduced based on site data and regulator concern with downgradient injections.	8	0,0,0,8	N/A	N/A	N/A	3
ST012-LSZ44	ST012-LSZ29	12	3	Eliminate injections at ST012-LSZ44 and extraction at ST012-LSZ29 due to low dissolved-phase benzene concentrations at ST012-LSZ29. Address ST012-LSZ44 concentrations through upgradient injections	0	0,0,0,0	N/A	N/A	N/A	N/A
ST012-LSZ45	ST012-LSZ12	12	3	Delay injections to monitor effects from injections at ST012-W37 and upgradient. Consider possible injections in subphase 4 (not shown on figure). Mass injection reduced based on site data and regulator concern with downgradient injections.	3	0,0,0,3?	N/A	N/A	N/A	4
ST012-LSZ46	ST012-LSZ12	14	3	Delay injections to monitor effects from injections at ST012-W37 and upgradient. Consider possible injections in subphase 4 (not shown on figure). Mass injection reduced based on site data and regulator concern with downgradient injections.	3	0,0,0,3?	N/A	N/A	N/A	4
ST012-LSZ47	ST012-LSZ11	26	6	No changes proposed for subphases 1-3. Move TEA injection quantity to ST012-LSZ11 for subphase 4.	19	6.5,6.5,6.5,0	2	3	3	N/A
ST012-LSZ48	ST012-LSZ11	29	7	No changes proposed for subphases 1-3. Move TEA injection quantity to ST012-LSZ11 for subphase 4.	22	7.5,7.5,7.5,0	2	2	2	N/A
ST012-LSZ49	ST012-LSZ23 ST012-LSZ39	30	7	No changes proposed	30	7.5,7.5,7.5,7.5 .5	2	2	2	2
ST012-LSZ50	ST012-LSZ09 ST012-LSZ38	27	7	No changes proposed	27	6.75,6.75,6.75,6.75	2	2	2	2
ST012-LSZ51	Injection not originally planned in ST012-LSZ51			Move TEA injection from ST012-LSZ17 to ST012-LSZ51 and inject entire TEA quantity in subphases 2&3 after extraction in ST012-LSZ51 is	15	0,7.5,7.5,0	N/A	2	2	N/A

Note

¹ Based on TEA mass in each zone (CZ, UWBZ, and LSZ).

² Amount is listed for each of the proposed four subphases. The entire Pilot Study Implementation is referred to as Phase 1 with four, approximately quarterly subphases.

CZ - cobble zone

LSZ - lower saturated zone

TEA - terminal electron acceptor

UWBZ - upper water bearing zone

ATTACHMENT 2 UPDATED FIGURES

Notes:

ST012-CZ23 Monitoring Well Identification

97 Benzene Concentration (µg/L)

<1.0 Not detected at or above the RL

Nov-17 Sample Date
(Apr-18 re-baseline event if not listed)

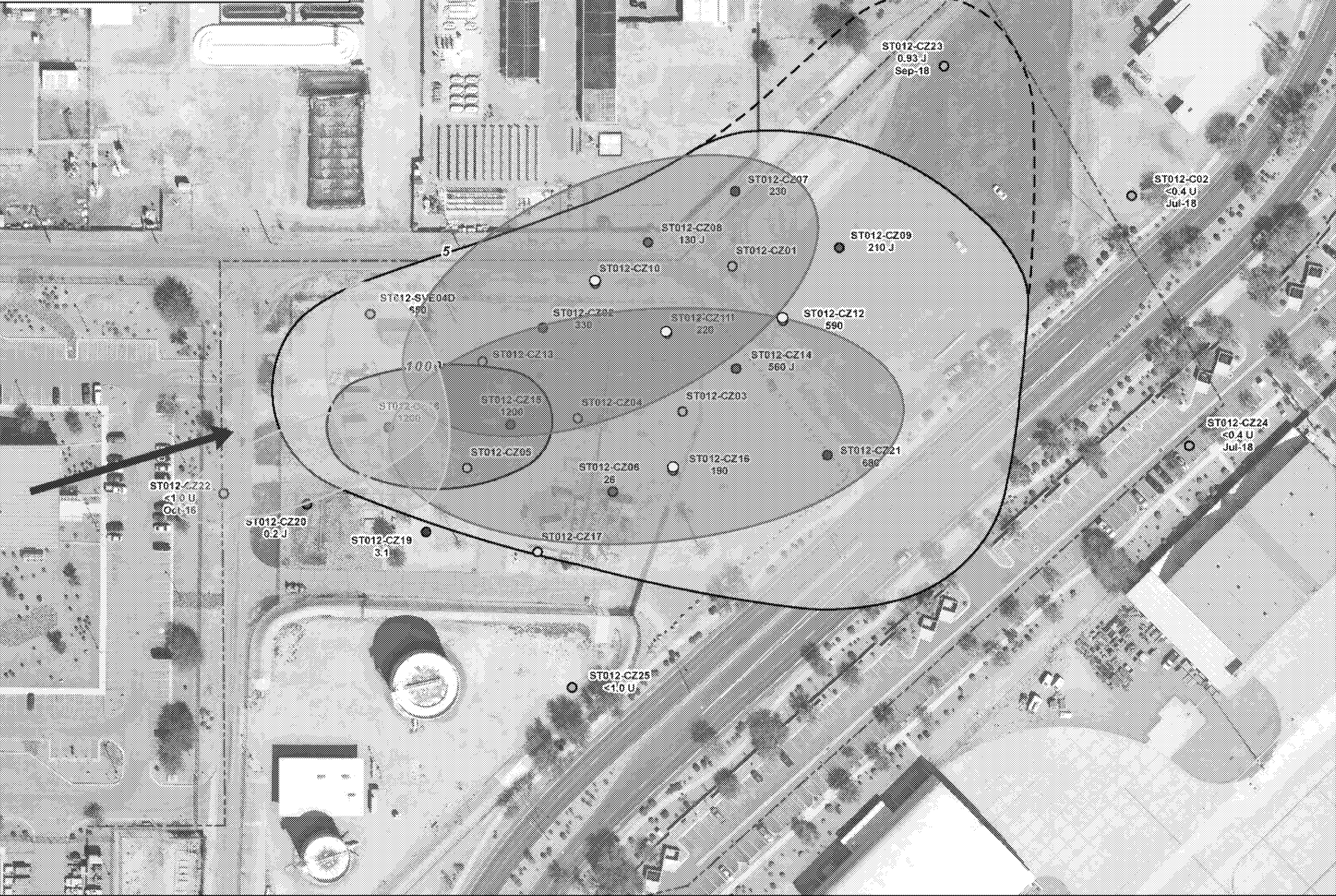
µg/L Microgram per liter

CZ Cobble Zone

J The analyte was detected; estimated due to quality control criteria

RL Reporting Limit

U The analyte was not detected above the RL



Legend

- Benzene Concentrations (µg/L) in Groundwater**
(Dashed Where Inferred)
- 5-999 µg/L
 - 1000-4999 µg/L
- Extraction Well Location
 - Injection Well Location
 - Groundwater Monitoring Well Location
 - Perimeter Groundwater Monitoring Well Location
 - Other Existing Well Location (Not in Defined Sampling Plan)
- Former (Apr-18) 5 µg/L benzene extent
 - ➔ Approximate Groundwater Flow Direction
 - ST012 Site Boundary
 - Primary Target Area of Sulfate Distribution By Injection-Extraction
 - Secondary Target Area of Sulfate Distribution by Extraction



Pilot Study Implementation
Site ST012 - Former Williams Air Force Base
Mesa, Arizona

ST012 CZ Modified Injection-Extraction Areas

FIGURE 3-2	Job No.:	9101110001
	PM:	DS
	Date:	11/9/2018
	Scale:	1" = 100'

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Notes:

ST012-UWBZ33 Monitoring Well Identification

3000 Benzene Concentration (µg/L)

3500/3700 Original/duplicate results

<1.0 Not detected at or above the RL

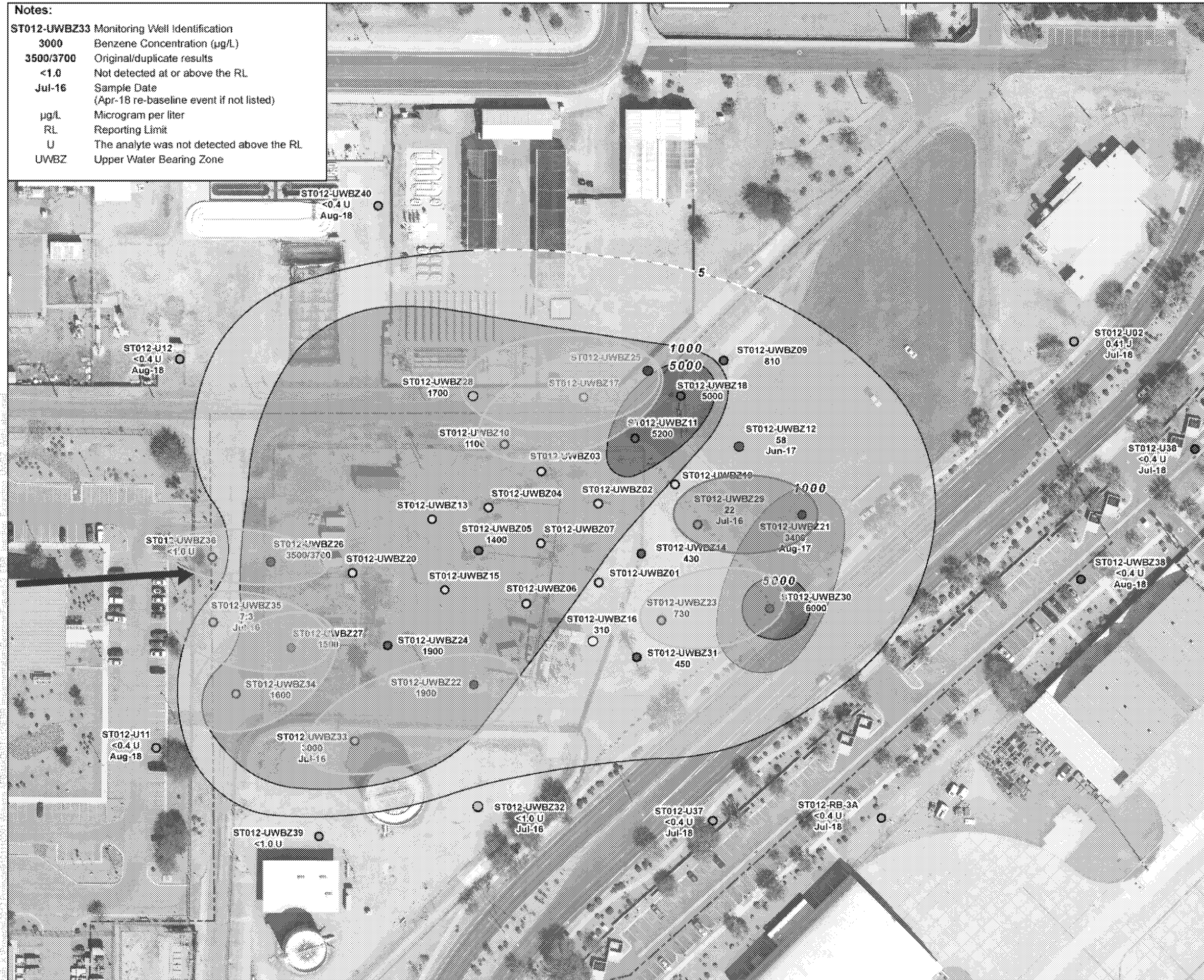
Jul-16 Sample Date
(Apr-18 re-baseline event if not listed)

µg/L Microgram per liter

RL Reporting Limit

U The analyte was not detected above the RL

UWBZ Upper Water Bearing Zone



Legend

Benzene Concentrations (µg/L) in Groundwater

(Dashed Where Inferred)

5-999 µg/L

1000-4999 µg/L

≥5000 µg/L

➔ Approximate Groundwater Flow Direction

● Extraction Well Location

○ Injection Well Location

● Groundwater Monitoring Well Location

○ Perimeter Groundwater Monitoring Well Location

○ Other Existing Well Location (Not in Defined Sampling Plan)

□ ST012 Site Boundary

○ Primary Target Area of Sulfate Distribution By Injection-Extraction

○ Secondary Target Area of Sulfate Distribution By Injection-Extraction During Subphases 3-4

0 25 50 100
Feet



Pilot Study Implementation
Site ST012 - Former Williams Air Force Base
Mesa, Arizona

ST012 UWBZ Modified Injection-Extraction Areas

FIGURE
3-3

Job No.: 9101110001
PM: DS
Date: 11/9/2018
Scale: 1" = 100'



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Notes:

ST012-LSZ26 Monitoring Well Identification

340 Benzene Concentration (µg/L)

2900/2500 Original/Duplicate Results

<1.0 Not detected at or above the RL

Nov-17 Sample Date
(Apr-18 re-baseline event if not listed)

µg/L Microgram per liter

F The analyte was positively identified but the associated concentration is an estimation above the MDL and below the RL

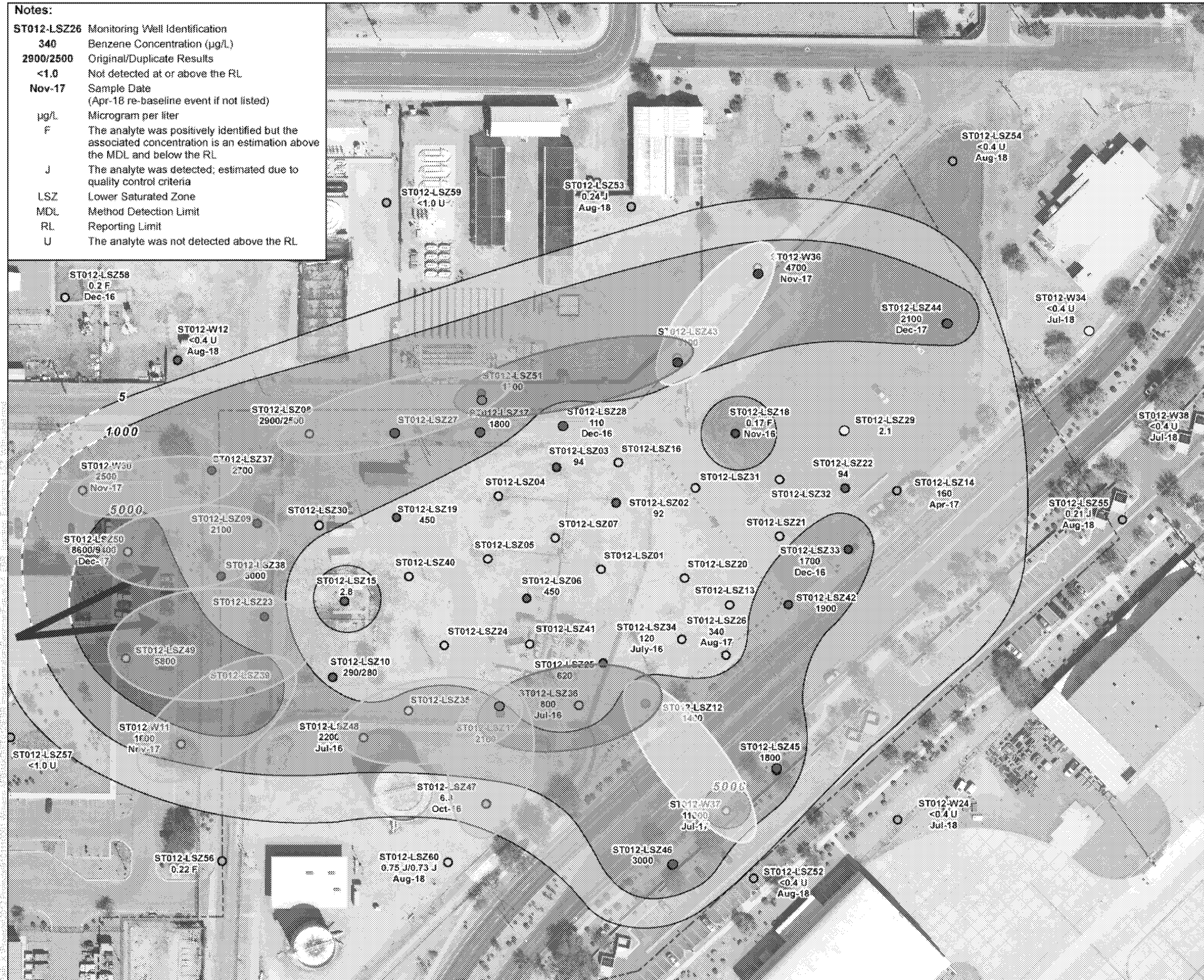
J The analyte was detected; estimated due to quality control criteria

LSZ Lower Saturated Zone

MDL Method Detection Limit

RL Reporting Limit

U The analyte was not detected above the RL



Legend

Benzene Concentrations (µg/L) in Groundwater

(Dashed Where Inferred)

5-999 µg/L

1000-4999 µg/L

≥5000 µg/L

Approximate Range of Groundwater Flow Direction

Extraction Well Location

Injection Well Location

Groundwater Monitoring Well Location

Perimeter Groundwater Monitoring Well Location

Other Existing Well Location (Not in Defined Sampling Plan)

ST012 Site Boundary

Primary Target Area of Sulfate Distribution By Injection-Extraction

Secondary Target Area of Sulfate Distribution By Injection-Extraction During Subphases 2-4

Tertiary Target Area of Sulfate Distribution By Initial Small Mass Injection-Extraction, then Subphase 4+

0 25 50 100
Feet



Pilot Study Implementation
Site ST012 - Former Williams Air Force Base
Mesa, Arizona

ST012 LSZ Modified Injection-Extraction Areas

FIGURE
3-4

Job No.: 9101110001
PM: DS
Date: 11/9/2018
Scale: 1" = 100'



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